

MANUFACTURING PROCESSES

SHORT CASES II

Prepared in the Department of Mechanical Engineering, University of British Columbia by C. Rosen. Printed with permission in the Design Division, Department of Mechanical Engineering, Stanford University, Stanford, California, with support from the National Science Foundation.

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INTRODUCTORY ASSIGNMENT SHEET

1. PURPOSE

The purpose of written case presentations is to:

- a) familiarize the student with the subject matter involved,
- b) give the student practice in analysing a problem and arriving at a solution,
- c) give the student practice in organizing a report and presenting recommendations to management.

2. ORGANIZATION OF REPORT

In most companies, management does not have time to go into details of a report. They are interested in the results and recommendations and will usually only look at the details if they disagree with the results.

a. Summary Page

The report should therefore begin with a summary page giving all the important points. The summary page should include the name or subject of the report, the writer's name, the date, the problem encountered, and the results obtained. A brief statement of the problem is all that is necessary. Facts from the cases should not be copied out.

The results or recommendations should be brief and to the point. Where a long list of results is required, the results should not be included in the summary, but referred to by page number. Wherever possible, results should be listed or tabulated.

b. Body of Report

The assumptions, explanations and discussion which lead to the results obtained are included in the body. Information given in the summary (i.e. purpose, etc.) should not be repeated in the body. The body should be systematically organized to lead up to the results desired. Tables, numbered paragraphs, and listing should also be used in the body to assist in its organization. Where several alternative methods or machines are being compared, advantages and disadvantages of each should be discussed.

c. Appendix

Graphs, exhibits, case sheets, and other supplementary information should be included in the appendix.

3. PRESENTATION OF THE REPORT

The report should be neatly written out and stapled together with the case sheet on the back. The pages should be numbered from the first sheet, and the summary page should act as the title page. The length of the report will vary with the different cases, but in any case, the discussion should be comprehensive enough to support the conclusions arrived at.

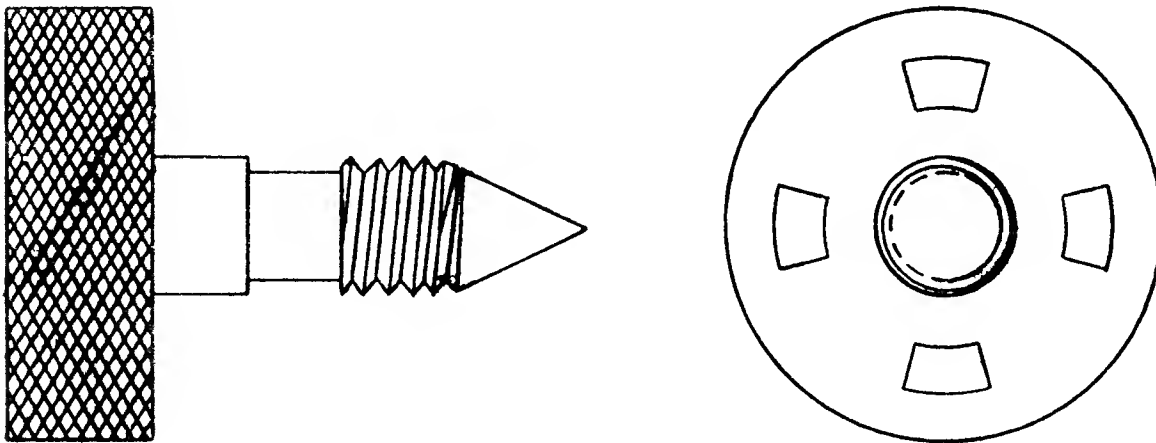
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BENSEN INDUSTRIES LTD. (B)

Bensen Industries are redesigning one of their older standard pumps. Since the product was initially marketed, many new methods and materials have been developed in manufacturing and requirements for the pump have increased substantially. Management therefore feels that some worthwhile savings can be achieved with a redesign.

Mr. Smith, their product design engineer, is investigating what can be done with the needle valve piece shown below. At the present time, the part is sand cast and threaded and finished on a turret lathe. Mr. Smith's first idea was to machine the part on an automatic screw machine and drill the flange holes needed for lubrication. However, this method would produce too much scrap which would counterbalance the labour saving.

His next idea was to investigate the possibility of making this part by powder metallurgy. Can this part be made by powder metallurgy? If so, what design changes are needed and how will the part be made? Keep in mind tool cost and tool life. Sketch the newly designed part.



Scale: Full
Tolerances: \pm .005

Material: Brass

COAST WELDING LTD.

Coast Welding is a small welding shop specializing in the fabrication of welded industrial items. Their equipment consists of several transformers suitable for manual stick welding and two units designed to do submerged arc welding. They also have acetylene cutting and welding equipment and an x-ray machine used for weld inspection. They have no gas shielded equipment and consequently do not accept work on stainless steel or aluminum.

At the present time they have an order for 10 of the vessels shown in the sketch and are trying to decide on the best method of welding. You are required to specify how the four main seams will be welded and to give a total cost of all the welding on one vessel (include labour and material). Assume the drainage nozzle and inspection window will be hand-welded to the main body.

Time standards: for 1/2" weld.

	<u>Manual</u>	<u>Submerged Arc</u>
Set up time per order	-	15 min.
Set up time per assembly	10 min.	10 min.
Set up time per seam welded	-	12 min.
Welding time per foot	6 min.	2.7 min.

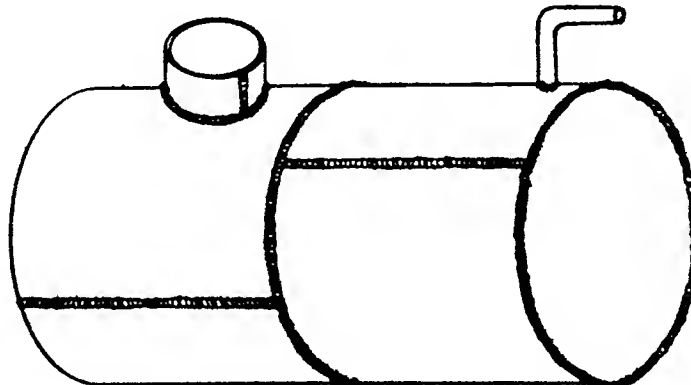
Material and Labour Costs:

Labour	\$3.00/hour
Material: submerged arc	\$.132/ft (includes flux)
manual	\$.178/ft

Further data:

Height of vessel:	6'
Drain of vessel:	3' O.D.
Length of inspection window:	6"
Drain of inspection window:	1' O.D.
Drainage nozzle - standard 2"	O.D. elbow
Thickness of vessel:	1/2"
No. required:	10

This
end
open



WESTERN STRUCTURAL STEEL LTD. (B)

Western Structural Steel was investigating the possibility of purchasing an automatic four torch flame cutting machine. Accessories included a photoscope sensing mechanism for following pencil lines. The machine could be operated from a drawing using the photoscope, from a metal template using a magnetic roller, or operated manually as with a wooden template.

The machine was expected to save labour costs in three ways:

- 1) By decreasing the use of shearing facilities.
- 2) By decreasing the use of radiograph burning facilities.
- 3) By decreasing the need for wooden and paper templates.

Time studies showed that labour required using burning was roughly 1/3 of that required for the same job using the process of layout, shearing, and straightening. Burned plates did not require as much layout, and straightening was not necessary. Shearing load at the present time was 12,000 man hours per year. It was estimated that one half of this load could be transferred to the burning machine with resultant labour savings.

Time studies on the radiograph burner showed this machine to take four times as long as the four torch multigraph. The present load on the radiograph machines was 3200 man hours, all of which could be transferred to the multigraph, if necessary. Both the radiograph and multigraph require only one attendant.

The decrease in the need for templates resulted in a net saving of 200 man hours per year.

Counterbalancing the labour savings was the increased need for acetylene and oxygen. It was estimated that when the multigraph machine was burning (70% of total operating time), it required 330 cu.ft. of oxygen per hour and 45 cu.ft. of acetylene per hour. The company cost of bulk oxygen was \$.0074/cu.ft. and of acetylene was \$.038/cu.ft.

Other charges against operating savings were maintenance, \$100/year; depreciation 10% of installed cost of \$23,000; and insurance and local machinery taxes of \$400 per year.

If the labour costs on these machines averaged \$2.50 per hour plus fringe benefits of 20%, what is the annual operating savings in dollars? If company policy requires a machine to pay for itself in two years from operating savings, should the company purchase the new machine?

BENSEN INDUSTRIES LTD. (B)

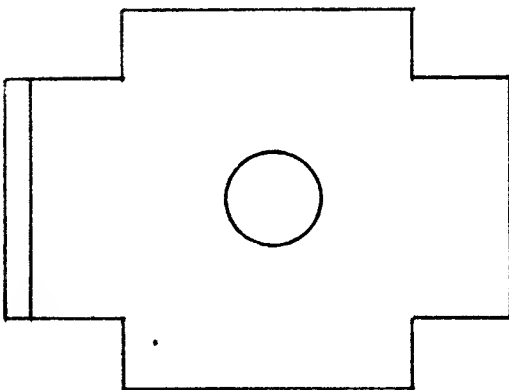
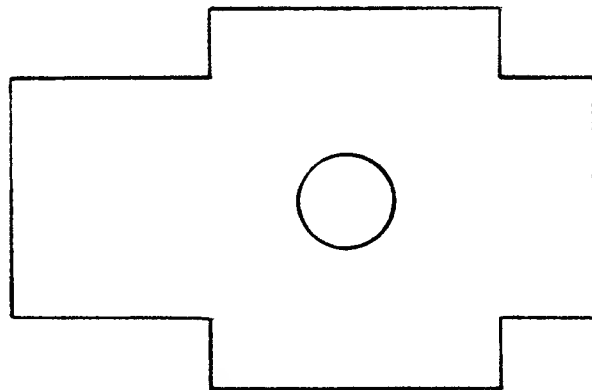
Bensen Industries are considering the manufacture of the bracket shown below. The expected production volume is not finalized at present so the company cannot decide what type of tooling should be built.

However, tool designers have suggested two possible alternative designs. The first alternative, a three station progressive die, is estimated to cost \$1000 to build, and yield a production volume of 1800 parts per hour. The other alternative would be to use two simple dies, a shear, notch and cut-off die, and a forming die. The shear, notch and cut-off die is estimated to cost \$400, and have a production rate of 600 parts per hour. The forming die is expected to cost \$200 and have a production rate of 300 per hour. Set up time for the progressive die will be two hours, and for the shearing die and forming die, 1/2 hour each.

Labour costs for the set up man, \$3.00/hour, and for a punch press operator, \$2.00/hour. Labour overhead, which is to be included in all calculations, is estimated at 100%.

Questions:

1. At what volume will both methods give the same unit costs? (Assume tools set up at once.)
2. If an annual depreciation expense of 25% of first cost is included as a cost, over what volume does it become economical to use a progressive die?
3. Could this part be made with a Combination tool? Explain and illustrate by means of a sketch.
4. (To be discussed in class and not required to be included with assignment.) What would a strip taken from the progressive die look like?

**(A) Workpiece****(B) Developed Blank**

Scale: 1/2 full size

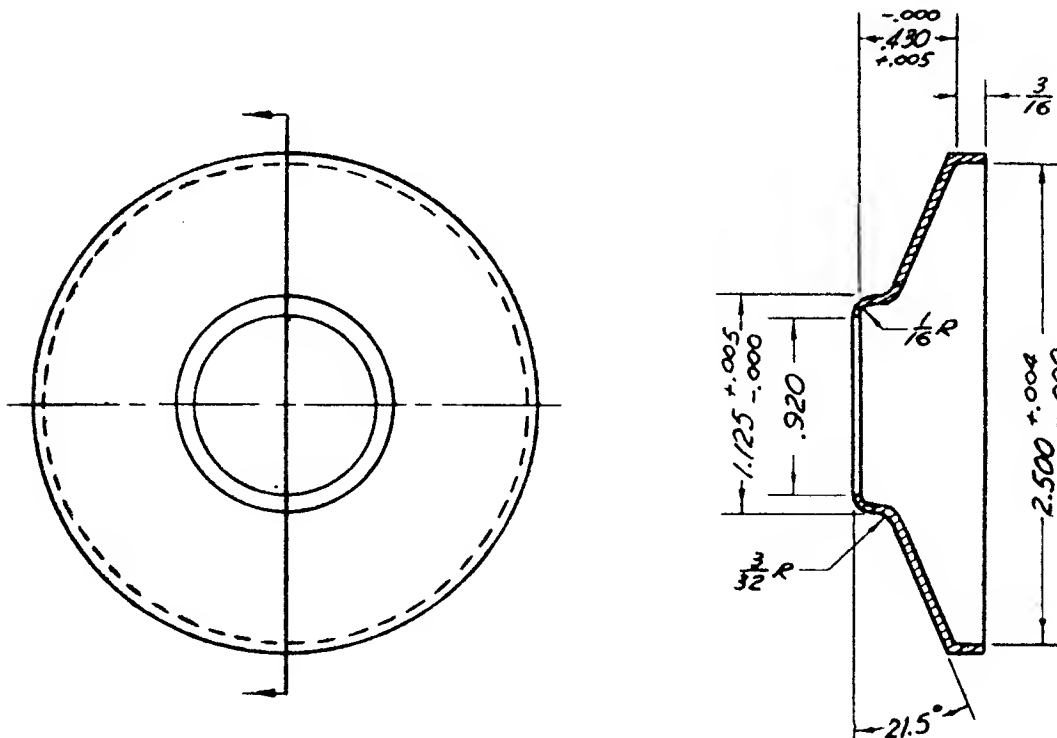
WESTCOAST LOCK CO.

The Westcoast Lock Co. is the largest manufacturer of locks and building hardware on the lower mainland. They have complete design and manufacturing facilities including a well-equipped tool room. Although most of the parts used in the lock assemblies are manufactured in their own plant, some of the items are imported from the main plant in San Francisco.

At the present time, the company is importing the doorknob backing plate shown in the sketch below.¹ It is expected the company will require 40,000 of the item in the next year, to be made up in 4 lots of 10,000.

The part will be made with a blanking and forming die on a punch press with the following dimensions: Throat width 16", Throat depth 14", Stroke 3", shut height = 8 1/2".

You are required to draw up a rough design of the type of die needed. Draw only the elevation of the die in cross-section in the closed position. Show the cross-section of the completed part in coloured pencil in the die. Remember that provision must be made for scrap removal and that in any forming operation, pressure must be maintained on the flat unformed section to prevent wrinkling.



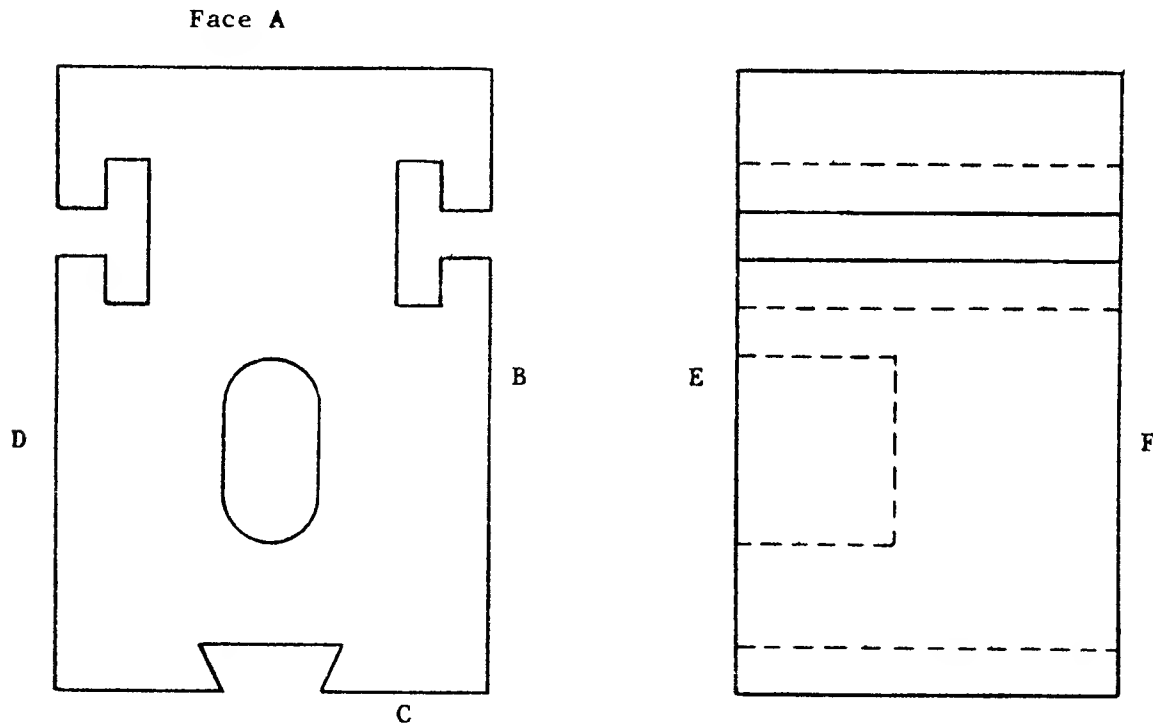
Footnote: 1. Copied from a company drawing of the part.

ECL 1-2
ME 4-2

BROWN MACHINE WORKS (B)

Besides their 16" x 24" shaper, Brown Machine Works have two other larger shapers and a slotter. Their milling machines consist of two horizontal plain milling machines, one universal machine, one vertical machine, and a 6' planer type machine.

An order has been received for the sliding block mechanism shown in the sketch. Describe in detail the operations, machinery and tooling required to produce a sample of one and a production order of 50 pieces.



Scale: Full
Tolerance: $\pm .003$

F.A.O. 125 RMS

WESTMINSTER GEAR WORKS

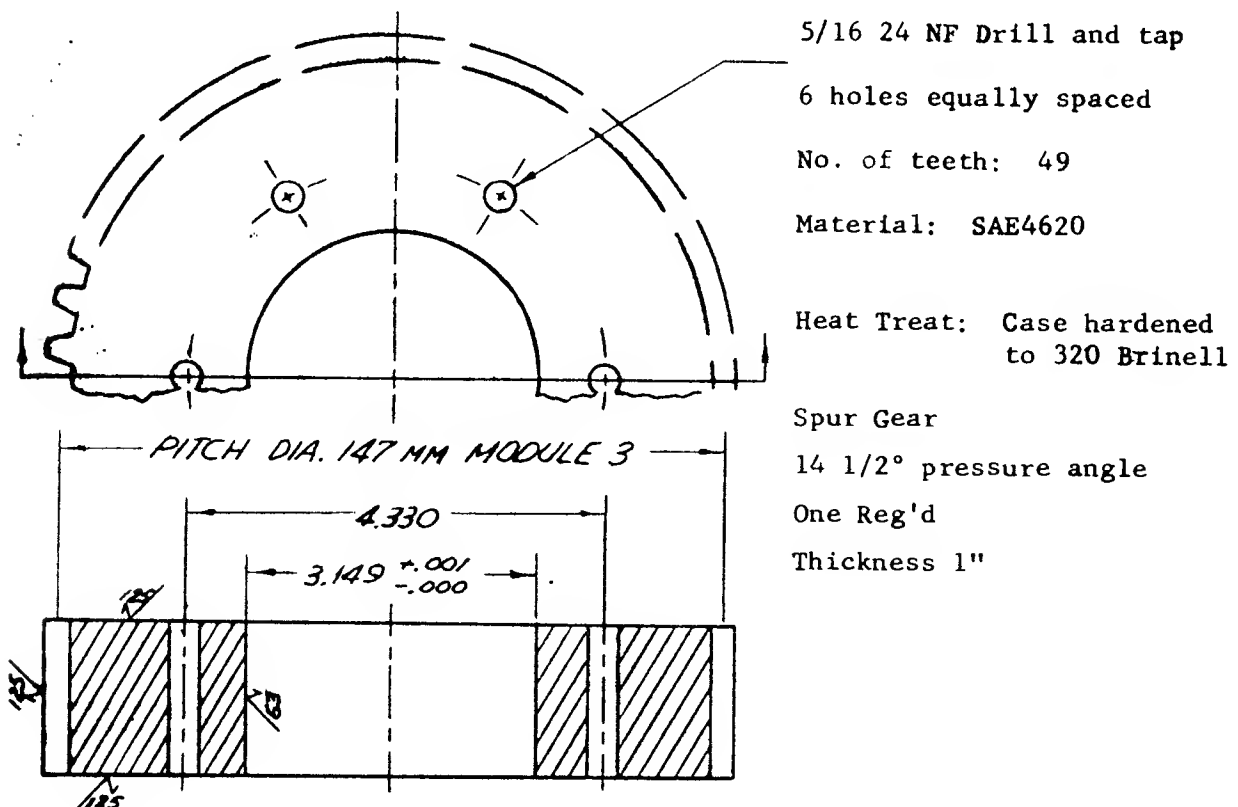
Westminster Gear Works supply most of the replacement gears in the lower mainland area. They also supply standard commonly used gearing manufactured by themselves and other companies.

Their shop contains four Fellows Gear Shapers, six hobbing machines, one end mill-type gear cutting machine, one internal grinding machine, one external gear grinder, one burnishing machine, and one gear lapper.

The standard machine tools included in the shop are three engine lathes, two turret lathes, four milling machines, two shapers, three drill presses, one cylindrical grinder, and two hack saws. They also have miscellaneous flame cutting, flame hardening, carburizing and welding equipment.

Most of their tooling is ordered from the suppliers. However, Westminster have the facilities to make up their own hobs and shaper cutters, and will do so for rush orders and specials.

A rush order has been received from the Aluminum Company for the gear shown in the sketch. List all the operations required to produce this gear. On which machine should the gears be cut?

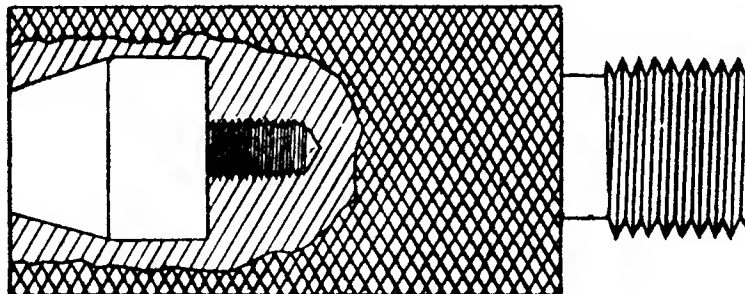


AL TOOLMAKERS LTD. (B)

Al Toolmakers is a small machine shop with the usual assortment of lathes, milling machines, shapers, planers, grinders, etc. They have just received an order for the shaft coupling shown below. You are required to explain in detail, step by step, how the coupling could be made. It is important to note the machine and tooling to be used, and how the material is held in the machine. Use the following outline in describing the procedure.

<u>Operation</u> <u>No.</u>	<u>Operation</u>	<u>Machine</u>	<u>Tooling</u>
1	Cut bar stock to length	Hack saw	

Material is cut to workable size from stock lengths.



Material: SAE 1020
Scale: Full Size
Tolerance: $\pm .001$

NOTE: Threaded portions
in both ends must
be lined up.

KNIGHT MANUFACTURING LTD.

The Knight Manufacturing Co. is a small machine shop specializing in turned products. Besides the usual machine tools, they have a number of turret lathes and manual and automatic screw machines.

The Sales Manager, Mr. George, has been asked to bid on a shaft for a local hardware manufacturer. The quantities mentioned were initially 100, followed by a further order of 2000, if the original 100 are acceptable. The growth potential for this product was very promising and it was expected that it would eventually build up to an annual production of 20,000 pieces.

The estimating department has come up with the following data:

South Bend Engine Lathe

Set up time - 10 minutes
Production rate - 12/hour
Labour Rate - \$2.50/hour

Warner and Swasey Turret Lathe

Set up time - 30 min.
Production rate - 20/hour
Labour rate - \$2.50/hour
Tooling - available.

Brown and Sharpe Manual Screw Machine

Set up - 1 hour
Production rate - 40/hour
Labour rate - \$2.50/hour set-up man
 \$1.80/hour production worker
Tooling - \$20.

Brown and Sharpe "OG" Automatic Screw Machine

Set up time - 3 hours
Cam cycle: 30 sec.
Labour rate - \$2.50/hour (one man sets up and runs
 3 machines)
Tooling - \$60

Acme-Gridley RA 6 Automatic

Set up - 6 hours
Cam cycle - 15 sec.
Labour - \$2.50/hour (3 machines/man)
Tooling - \$90

On which of the machines should the orders of 100, 2000, and 20,000 be made? Remember that on the automatic machines, the operator will be running two other jobs consecutively, and consequently labour must be split between the three jobs. To arrive at your conclusion, show a comparison of total costs for the different quantities on the machines which would be considered.

What other factors should be considered besides total job costs?

NORTH SHORE MANUFACTURING LTD.

North Shore Manufacturing employed approximately 300 people. The main departments were:

- 1) Punch Press Dept. - containing 25 punch presses.
- 2) Milling Dept. - containing 15 milling machines
- 3) Screw Machine Dept. containing 30 screw machines and turret lathes.
- 4) Drilling Dept. - containing 40 drill presses.
- 5) Assembly Dept. - containing miscellaneous assembly equipment.

The management had recently decided to set up their own tool room. Previously, all toolmaking had been subcontracted, including grinding and sharpening of punch press tooling and milling cutters. Set-up men in the drilling and screw machine departments had been doing their own grinding on small pedestal grinders located in their own departments.

As is always the case, the budget for the new toolroom equipment was limited and only the most useful equipment could be purchased at present.

You are required to recommend what grinding machines should be purchased. You are also asked to specify the type of grinding wheels to be used on

- 1) Cast iron machine parts
- 2) High speed cutting tools
- 3) Carbide tipped cutting tools

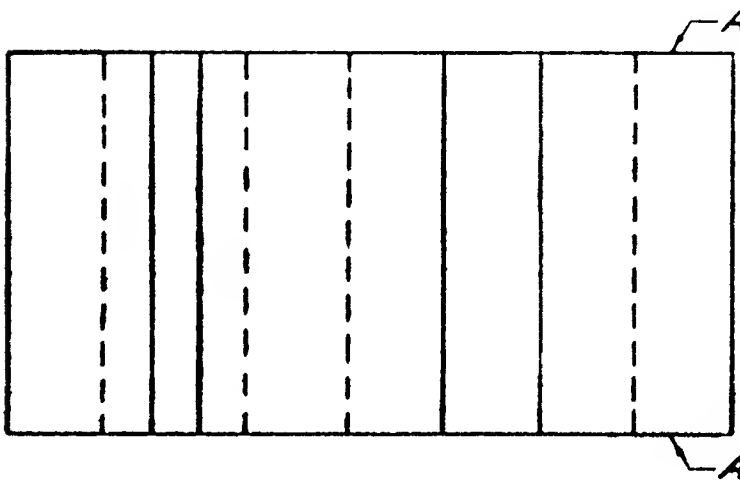
Some representative costs of grinding machines are:

- | | |
|---|--------|
| a) Surface grinder 12" x 24" horizontal spindle | \$3500 |
| b) Centreless grinder 6' length | \$7000 |
| c) Universal grinder | \$5000 |
| d) Tool and cutter grinder | \$1000 |

ECL 1-2
ME 4-2

NORTH SHORE MANUFACTURING LTD. (B)

North Shore have received an order for the blocks shown in the sketch. Describe fully the operations, machinery, and tooling required to produce a sample of two, and a production order of 100. The blocks will be machined from 1" x 4" C.R. bar stock.

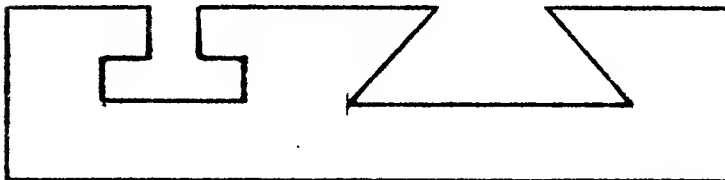


F.A.O. 125 RMS
except face A
at 63 RMS

Scale: Full

Mat'l: SAE 1020

Tolerance: $\pm .003$



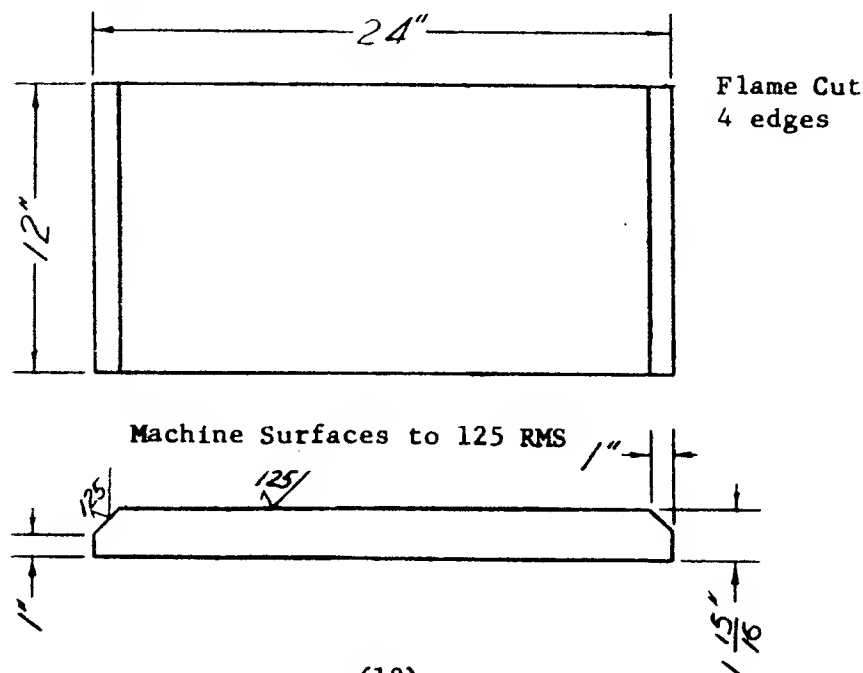
BROWN MACHINE WORKS (A)

Brown Machine works is a small machine shop specializing in manufacturing and repairs for the tugboat and fishing industry. The manager, Mr. Brown, has received an order for a surface plate shown below and a possible future order for 6 more of the same item. The plate will be burned from 2" boiler plate to rough dimensions and then finished on either the shaper or milling machine.

The shop has a Brown and Sharpe shaper with a maximum stroke of 16" and a table travel of 24". The cutting stroke to return ratio is 1.5 to 1. Using a high speed tool bit and cutting at 90 fpm, Mr. Brown decided he would need two cuts feeding .04" and .02" in order to achieve the required surface finish. He estimates the shaper will take 5 minutes to set up and it will take 10 minutes to cut the two bevelled edges.

The other alternative is to use the Cincinnati plain milling machine which has dimensions of 30" x 16". Mr. Brown decides to use a 4" diameter x 3 1/4" width x 22 teeth plain milling cutter which will cover the 24" length in four passes. His handbook shows that with a cutting speed of 90 fpm he can use a feed of .013" per tooth on the rough cut and a feed of .020" per tooth on the finish cut. He estimates the set-up time for the milling machine will be 25 minutes. Time to reposition table after each cut would be .5 minutes.

Assuming the loading and unloading time for the plate is five minutes for each machine, and the shop does not have a bevel cutter available, on which machine or machines should the order of one and the order of 6 be made?



BENSEN INDUSTRIES LTD.

Bensen Industries is a medium sized company engaged in the design and manufacture of valves, fittings, and other hydraulic equipment. The main shop departments are the milling, shaping and broaching department, the lathe department, the punch press department, the drilling department, the finishing, coating and grinding department, and the assembly department.

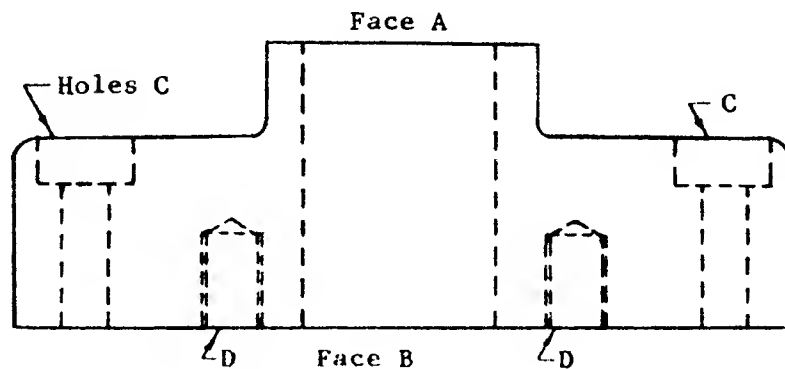
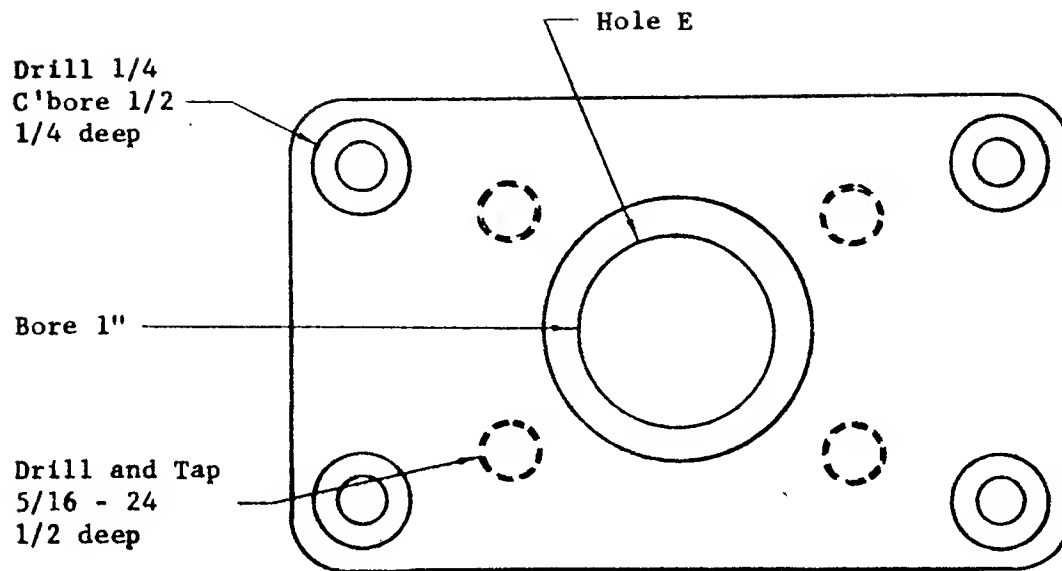
The drilling department contains 30 drill presses including upright drills, bench drills, radial drills, gang drills, multiple spindle drills, turret drills, universal drills, horizontal and vertical boring mills, and a jig boring machine.

At the present time the company is developing the work methods and tooling on a newly designed addition to their pump line. The sales department is predicting an annual requirement of 2000 pumps to be made up quarterly in batches of 500.

Mr. Black of the production planning department is working on the pump side plate shown on the sketch. He has decided to purchase the cast piece, face surfaces A and B in the milling department, and send the part to the drilling department for finishing.

What are the various operations, methods, machinery, and tooling Mr. Black should specify to complete this part? Should the part be placed in a drill jig for the various operations, and, if so, where should the holes locate from.

BENSEN INDUSTRIES (Con't)



Material: Cast iron with central 3/4" core hole

Tolerances on hole location: $\pm .002$

Machina: faces A and B parallel

Deburr holes C and D on face B

WESTERN STRUCTURAL STEEL

Western Structural Steel does a large volume of business fabricating and erecting steel frame buildings. At the present time, all beams, channels, and angles are cut to length on a friction saw which is kept busy an average of three hours per day. The three hours are divided up into material handling 1 1/2 hours, chipping off saw burs 1 hour, and sawing 1/2 hour. The friction saw requires a crew of three men who are kept busy on other jobs when not operating the saw.

After the burs are removed, the column pieces are taken to the Futurmill to face and square off the ends. This operation keeps two men busy two hours per day.

Management is considering replacing the friction saw with a cold saw. The advantages of a cold saw are better dimensional accuracy, absence of burs, and better finish. A cold saw, however, is much slower than a friction saw in sawing time. The company industrial engineer estimates that a cold saw with a proper material handling set-up will eliminate deburring and futurmilling, will reduce handling time to one hour per day and will increase sawing time to one hour per day.

Management policy on machine replacement is to require the new machine to pay for itself out of operating savings within a period of three years. Savings are calculated on an average direct wage rate of \$2.50 per hour plus 40% to cover unemployment insurance, holiday pay, retirement fund, and other fringe benefits. Maintenance is also included which would be \$200 per year on the friction saw and nothing on the cold saw. Scrap value of the friction saw is \$200. Cost of a new cold saw is \$21,000.

Should the company replace the friction saw under its present operating volume? If not, at what operating rate (in hours per day on friction saw) should the company make the change? What other factors besides cost savings should the company consider before deciding on a change?

CHASE CLOCK CO. (B)

This company was one of the largest Canadian manufacturers of electric and mechanical clocks. The results of a recent market research survey showed a need for small rugged waterproof alarm clocks for use by campers, travellers and small boat owners.

The design department had been asked to prepare a tentative design with cost estimates for the proposed new clock. The housing for the clock would be cup-shaped, 3 in. in diameter, 2 in. thick, and open on one side to receive the glass crystal. The part will be drawn on a punch press from mild steel strip stock.

The designer cannot decide what type of a protective coating to use on the housing. The alternatives he has considered are baked enamel, 2 mil chromium, 1 mil nickel, and 5 mil cadmium.

PROBLEM: Discuss the four alternatives plus any other solution you recommend in terms of appearance, cost, and serviceability. Which type of coating do you recommend?

VARIETY MANUFACTURING CO. LTD.

Variety Manufacturing Co. Ltd. is a small company supplying products to some of the other industries in B.C. Their products include wooden and metal paper roll cores and spools for the pulp and paper industry, furniture legs and other turned products for secondary industries in B.C., and peaveys, pike poles, cant hooks, and other miscellaneous tools for the logging industry.

Over the years, as the company had grown, they had added to their present buildings, and had built several new buildings. As a result, their manufacturing and office was spread over five different locations around their central storage yard.

The supervision of the company consisted of the dynamic, profit-minded general manager, Mr. Hollingshead, and his easygoing foreman, Mr. Sinclair. Hollingshead was constantly critical of Sinclair's abilities as a foreman, claiming that the productivity of the men was so low it was almost minus. On the other hand, Hollingshead was constantly loading down Sinclair with minor jobs and office work.

The company paid very low wages and as a result attracted a very poor calibre of labour. Some of these were (1) the lift truck operator, Killam, who was bright enough but seemed to have his mind on other things, (2) the maintenance mechanic, Marks, who was convinced everyone was against him and the operators were doing their best to ruin all of the machinery, and (3) the sweeper, Masse, who did some production work, but who Hollingshead felt was not bright enough to run a machine. Many of the operators, Baulkham, Whetter, Vanderlinde, Scott, Nishimura, Kidston, Everett, Holgate, and McKnight, had immigrated into the country in the last one to five years and had various abilities in writing and understanding English. The remainder of the crew had been picked up in the False Creek area where the plant was situated and included Hagkull, Reid, Brown, Spence, and Vermette. All of these were fluent in English although some of them couldn't read and write very well.

To keep up to the demand for furniture legs and wooden cores, Sinclair had to maintain two shifts on these jobs. The wooden cores were produced on two side by side automatic machines operated by Hagkull. The operator was required to feed 6" diameter by 8' legs into the machines by hand and to check the size and quality of the product produced. The turned cores were conveyed from the machines and dropped into open sacks held on stands. It was also Hagkull's duty to see that the proper number of cores were contained in each sack, after which the sack was replaced with an empty one. The other operators on this job were Whetter, who ran a dowelling machine to bring the raw material to the proper diameter, and Masse, who sewed up the sacks and piled them on pallets for kiln drying.

VARIETY MANUFACTURING (Con't)

The furniture legs were roughed out on a lathe operated by Everett, and sanded on an automatic sander operated by Nishimura. They were moved to another building for spray finishing by Holgate.

The two shift operation had brought complaints from Marks who could not keep the run-down machinery in the plant running properly; from Killam who had a huge pile of work to move first thing in the morning, and from Masse who felt he had too many sacks to sew up in the morning besides his regular sweeping duties. Hollingshead had refused to put another sweeper on afternoon shift, claiming that it was not a full-time job and Masse, at best, moved at half speed.

Sinclair was also receiving complaints from Vanderlinde and Reid. Vanderlinde, who worked in the finishing room, claimed that he was losing time because he had to wait for the lacquer to dry on the furniture legs before he could pack them. This, he felt, was due to the lower temperature at night.

Reid, who dowelled logs on afternoon shift, was complaining that he spent too much time running the lift truck to keep himself supplied with logs, and he couldn't keep up with the two core machines.

In commenting on two of the complaints, Hollingshead said that Vanderlinde was a chronic complainer and was only using this as an excuse to loaf, and Reid's complaint was only temporary since both core machines were producing long cores and required more logs. By next week, he claimed, Reid would be sitting down half the time since they would be working on shorter cores.

The logging tool business had been declining in the last few years and Kidston, the operator, claimed he spent as much time setting up machinery as he did operating.

The steel paper roll cores were produced in a separate building in batches of ten to twenty thousand. They were drawn on a large drawing press after first blanking from strip stock, and then given three successive drawing operations. Since there was only one press, all of one operation had to be completed before the next operation could start. Because of the size of the cores, a great deal of storage space was needed. McKnight, the operator, complained that because he was in a separate building he could never get the lift truck to come when he needed it. He therefore had to go looking for the lift truck whenever he had finished a pallet load of cores.

After checking the profits during the last month, Hollingshead blew a fuse and decided that something had to be done. He was convinced that a wage incentive plan was the answer to his problems and proceeded to bring in a firm of management consultants.

VARIETY MANUFACTURING (Con't)

You, as a management consultant, are required to prepare a preliminary report to Mr. Hollingshead giving him your recommendations. Your report should start with a summary page and cover the following points:

1. Problems which must be rectified before installation of an incentive plan.
2. As an example, the methods that would be used to arrive at standard times for the wooden core operation and the furniture leg operation.
3. How production from each machine would be recorded and quality controlled.
4. How Marks, Killam, and Masse would fit into an incentive scheme.
5. Type of incentive plan recommended.
6. Advisability and chances of success for the scheme.